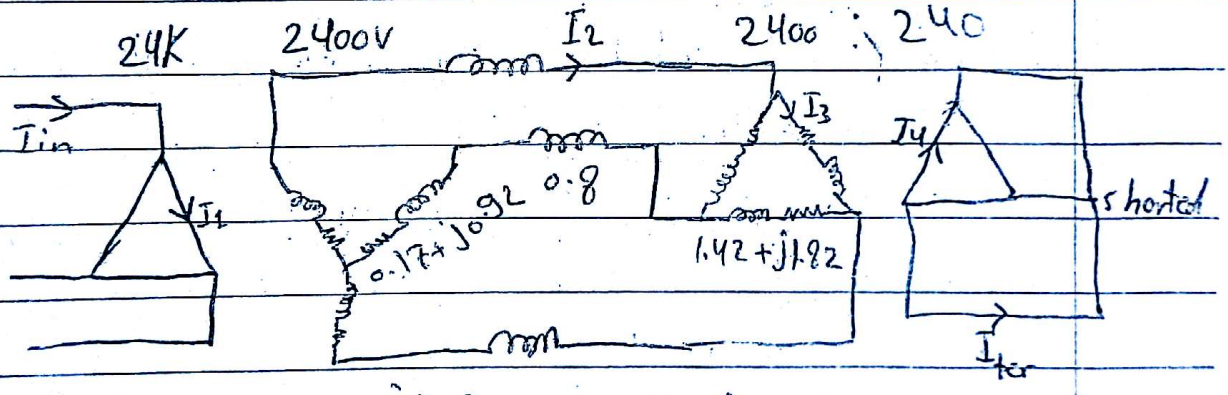
Tutorial #3

2015

Three phase transformer has impedance 1.42 + j 1.82 Ω connected Δ-Δ (2400-240 V) 150 KVA, the impedance refered to high voltage side. the transformer supplied with feeder whose reactance is 0.8 Ω/phase. the feeder connected to secondary terminal of three phase Δ-Y connected transformer whose rating 500 KVA, 24 KV 2400 V line to line. the equivalent series impedance of sending end transformer is 0.17 + j 0.92 refferred to 2400 V side

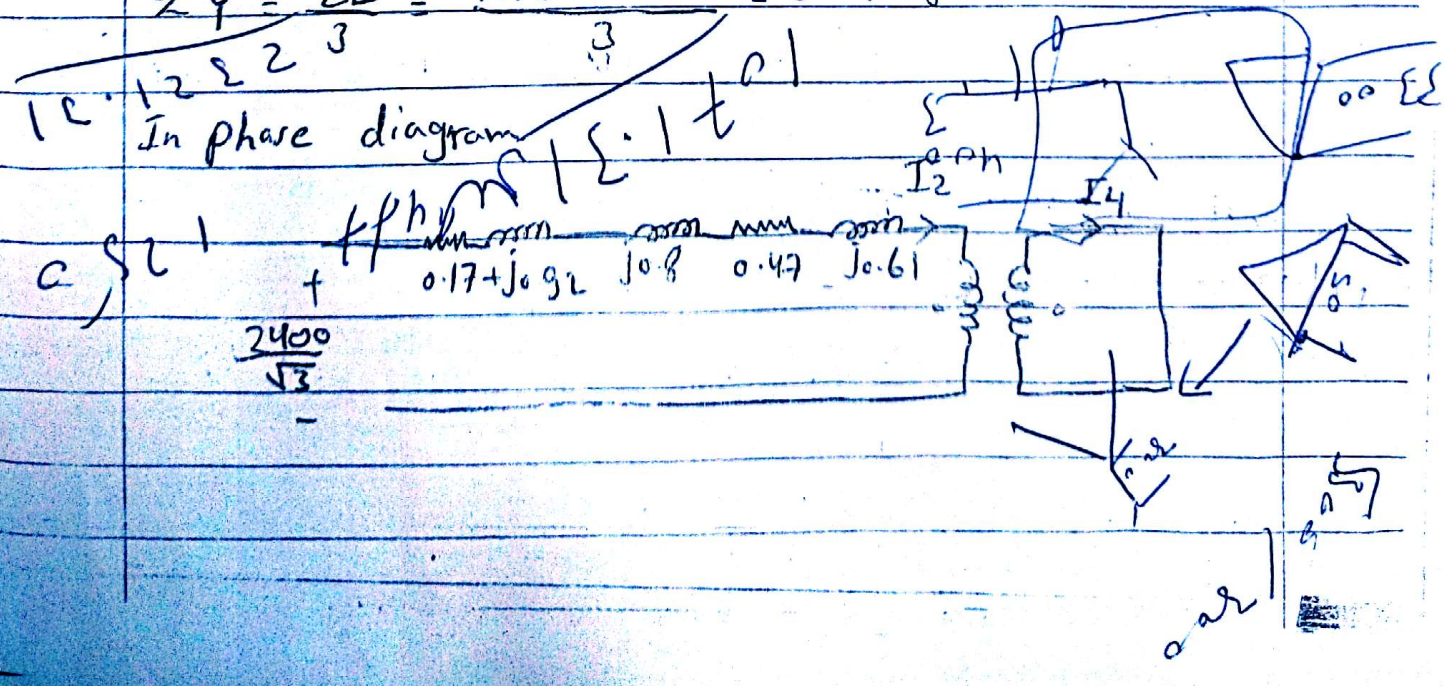
Find :-

(1) if short circuits occured in 240 V side, find currents in winding & terminal



$$Z_Y = \frac{Z_\Delta}{3} = \frac{1.42 + j1.82}{3} = 0.47 + j0.61\ \Omega$$

In phase diagram



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$Z_{tot} = 0.17 + j0.92 + j0.8 + 0.47 + j0.61 = 0.64 + j2.33$

$|Z_{tot}| = 2.42\ \Omega/ph$

$I_2 = \frac{2400/\sqrt{3}}{Z_{tot}} = \frac{1385.6}{2.42} \cong 572\ A$

$I_3 = \frac{I_2}{\sqrt{3}} \cong 330\ A$

$I_4 = \frac{N_1}{N_2} \cdot I_3 = \frac{2400}{240} \times 330 \cong 3300\ A$

$I_{terminal} = 3300 \times \sqrt{3} \cong 5715\ A$

Q2 A Δ-Y connected bank of 3 identical 100KVA 2400 : 120 V, 60 Hz single transformers, is supplied with power through feeder whose impedance is $0.065 + j0.87\ \Omega$ per phase. the voltage at sending end of the feeder is held constant at 2400 v line to line. the result of a single phase short circuit test on one of the transformers with its low voltage terminal shorted are :-

VH = 57.4 V, f = 60Hz, IH = 41.7A, P = 832 W

[a] Determine the L-L voltage on low voltage side of the transformer when the bank deliver rated current to a balanced three phase unity power factor load.

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[b] Compute the currents in transformers high & low voltage winding and in the feeder wires, if a solid 3 phase short circuit occurs at the secondary line terminals.

Ans 2 for single transformer we find z_{eq}, r_{eq}, x_{eq}

$$|z_{eq}| = \frac{V_H}{I_H} = \frac{53.4}{41.7} = 1.28\ \Omega$$

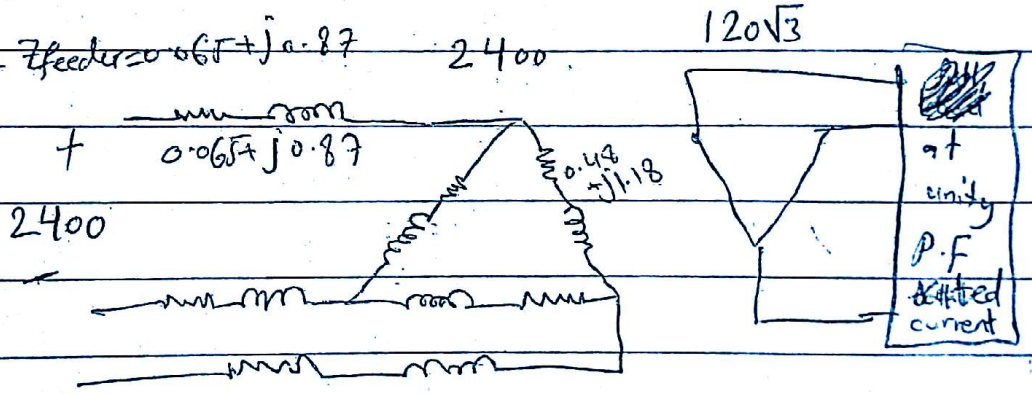
$$R_{eq} = \frac{P}{I_H^2} = \frac{832}{(41.7)^2} = 0.48\ \Omega$$

$$\rightarrow x_{eq} = \sqrt{z_{eq}^2 - R_{eq}^2}$$

$$x_{eq} = 1.18\ \Omega$$

$$z_{eq} = 0.48 + j1.18\ \Omega$$

$z_f = z_{feeder} = 0.065 + j0.87$



$$z_{eqY} = \frac{z_{eq\Delta}}{3} = \frac{0.48 + j1.18}{3} = 0.16 + j0.39\ \Omega$$

$$z_{tot} = z_f + z_{eqY} = 0.225 + j1.26\ \Omega$$

using line to line ratio $(2400 : 120\sqrt{3})$

$$z_{tot_2} = \left(\frac{120\sqrt{3}}{2400}\right)^2 z_{tot} = (1.68 + j9.45) \times 10^{-3}\ \Omega$$

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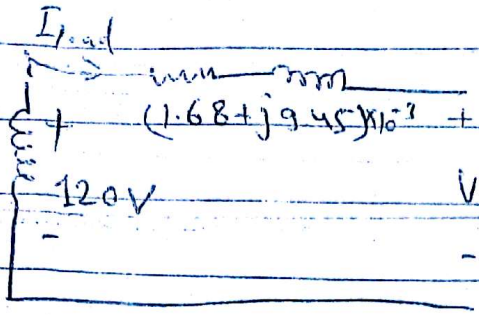


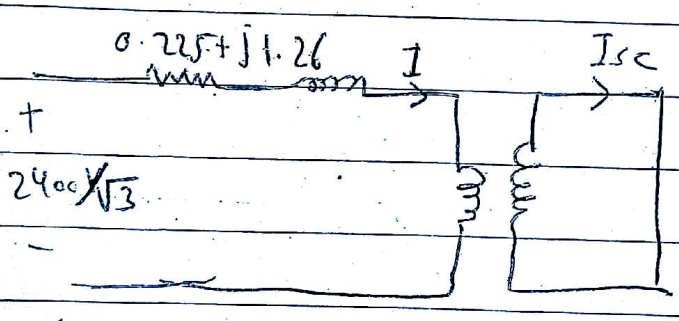
$$V_{load} = 120\,V - I_{load}(Z_{tot})_2$$

$$I_{load} = \frac{S_{one\ phase}}{V} = \frac{100\,KVA}{120} = 833.33\,A$$

$$\therefore V_{load} = 120 - 833.33\left[(1.68 + j9.45)\times10^{-3}\right]$$

$$V_{load}|_{ph} = 118.86\ V \Rightarrow V_{load}|_{L-L} = \sqrt{3}\times 118.86 = 205.87\,V$$

[b]



because it. Y

$E_{ph\,Y} = I_{L-L}$

$$I = \frac{2400/\sqrt{3}}{|Z_{tot}|} = \frac{2400/\sqrt{3}}{1.28} = 1082.53$$

$$I_{ph_\Delta} = \frac{1082.53}{\sqrt{3}} = 625\,A$$

$$I_{sc_{ph}} = \frac{N_1}{N_2} = \frac{2400}{120} I_{ph_\Delta} = 12.5\,A$$

$$I_{sc_{L-L}} = 12.5\,A \ \#$$

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